3.25 Integration Functional Element Sensitivity

The purpose of the signal integration function is to coherently sum a number of signal/noise pulses. Since the signal is coherent and the noise is random, there is an effective improvement in the ratio of signal to noise. For perfectly coherent signals and random noise, the theoretical integration gain is directly proportional to the number of pulses integrated. However, for fluctuating targets, the signal return is amplitude modulated, resulting in a fluctuation loss of the integrated signals (relative to a static or non-fluctuating target signature). Therefore, the integration gain is less than that for a non-fluctuating target. Clutter return signals are also coherent signals and will experience non-fluctuating target integration gain. The number of pulses integrated is a function of the radar PRF, beamwidth, and antenna scan rate.

Data Items Required

Data Item		Accuracy	Sample Rate	Comments
6.3.1	Pulses integrated	±1 pulse	PRF	
6.3.2	Target RCS	±0.5 dBsm	10 Hz	
6.3.3	Detection time	±0.5 s	SV/T	
6.3.4	Target echo	±0.5 dB	10 Hz	
6.3.5	Receiver noise figure	±1 dB	SV/T	

3.25.1 Objectives and Procedures

The integration function is sensitive to both Swerling target fluctuation type and the number of pulses integrated. This function impacts the S/N ratio and, therefore, detection range.

RADGUNS was exercised with the following input conditions:

a.	Model mode:	DETR
b.	Target RCS:	1.0 m^2
c.	Target altitude:	200 m (clutter/multipath disabled)
d.	Target fluctuation type:	Swerling 1, Swerling 2, Swerling 3, Swerling 4
e.	Flight path:	LINEAR
f.	Radar type:	RAD1
g.	Guns:	Disabled
h.	Pulses integrated:	1, 17, 33 and 66
i.	Probability of false alarm	10^{-8}
j.	Output:	S/N ratio and detection range

3.25.2 Results

Figure 3.25-1 shows the effect of the number of pulses integrated on detection range for each Swerling case.

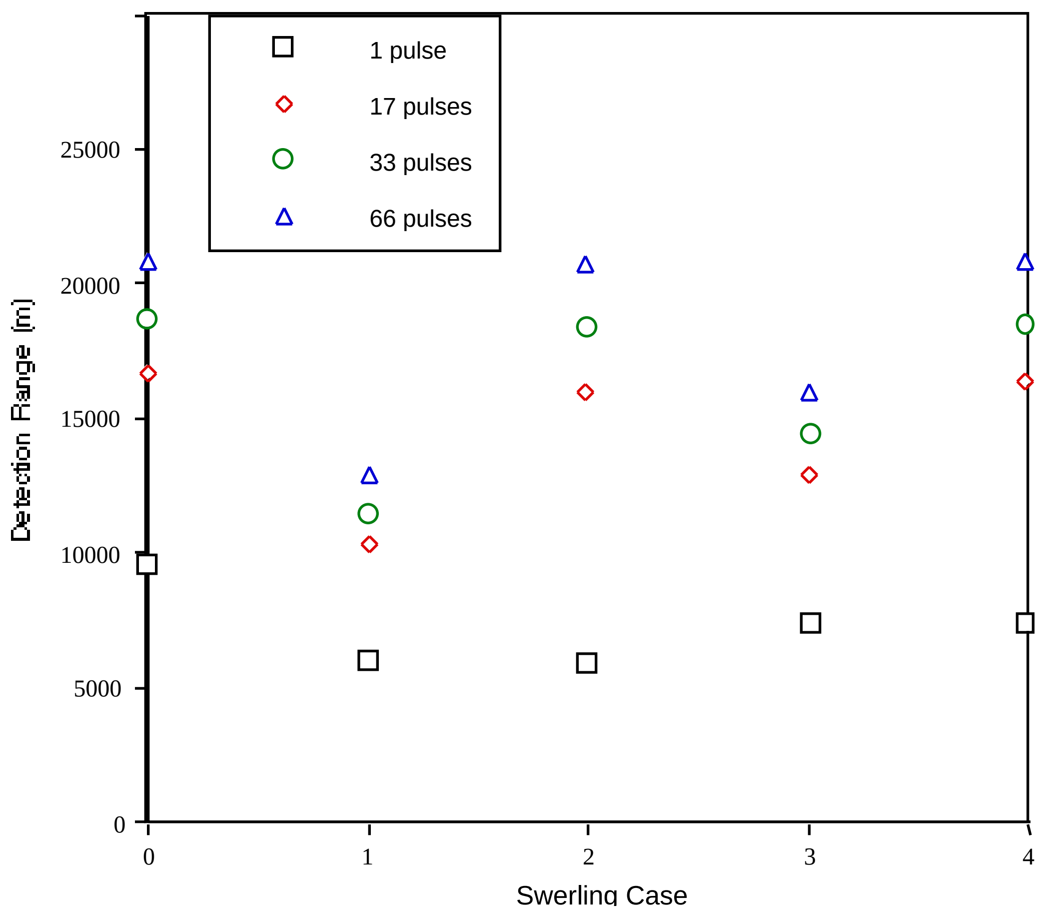

Figure 3.25-1. Effect of Integration Number on Detection Range.

Integration improves the S/N ratio because target signals combine additively while noise samples do not. Thus, as the integration number increases, the S/N ratio stays the same, causing the target detection range to increase. To detect a target with only one pulse, the target must be relatively close (5900 to 9500 m depending on the Swerling case) and the S/N ratio must be high. Integrating 66 pulses more than doubles this range of values (12,700 to 20,900 m).

The effect of the number of pulses integrated on the minimum S/N ratio required for detection is shown in Figure 3.25-2 for each Swerling case. Integration decreases the minimum S/N ratio required for detection. To detect a target with only one pulse, the S/N ratio must be between 14 and 22; whereas, to detect the same target with 66 pulses integrated, a S/N ratio of only 0.5 to 9 is needed.

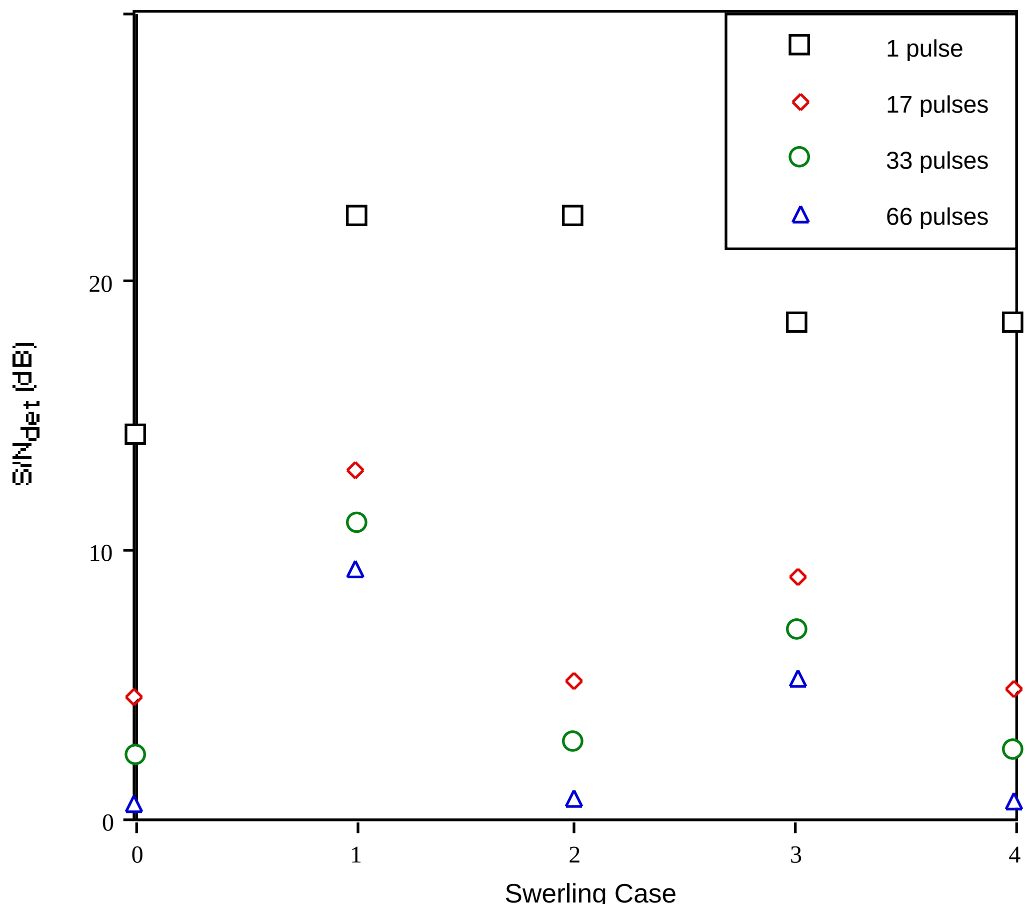

FIGURE 3.25-2. Effect of Pulses Integrated on Minimum S/N Ratio Required for Detection by Swerling Case.

3.25.3 Conclusions

The sensitivities of target detection range and minimum S/N ratio for detection to a 50% decrease or 100% increase in the nominal number of pulses integrated (33) are shown in Table 3.25-1. A 50% decrease or 100% increase in the nominal number of pulses integrated causes a change of ±11% to 13% in target detection range; this is considered to be relatively moderate sensitivity.

TABLE 3.25-1. Sensitivities of Detection Range and Minimum S/N for Detection.

Swerling Case	% Variation in Detection Range	% Variation in S/N at Detection
0	±12	±57
1	±11	±54
2	±13	±69
3	±11	±55
4	±12	±63